The Star Method

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Overview

1. The Problem
2. Stars
3. Triangles
4. Transitions
5. Can Inventory Management
6. Route Building
7. High-Level Look
8. Results
9. Conclusions/Future Work

Sam’s Hauling

What do they do?

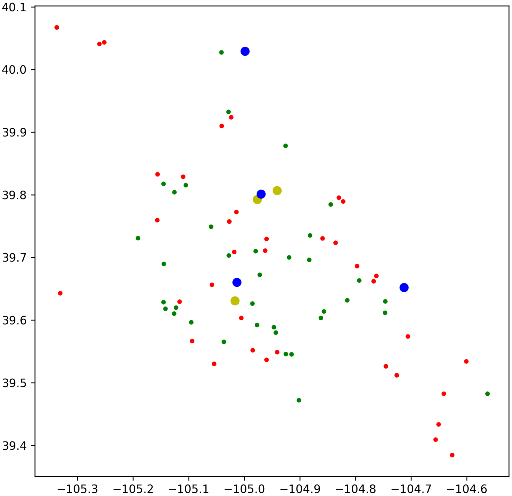
- Provide roll off dumpsters of various sizes (cans)
- Customers
  - Delivery
  - Pickup
  - Switch

Sam's Hauling

How do they do it?

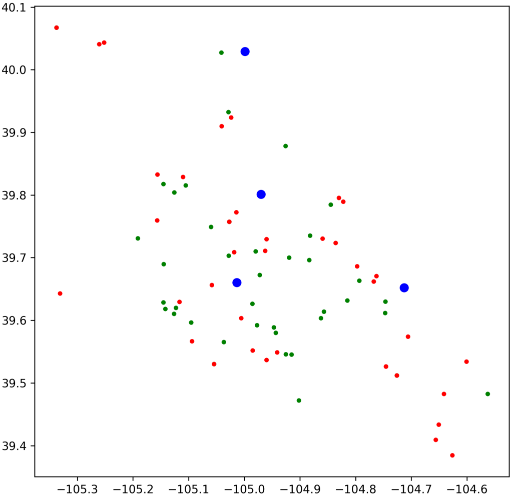
- Resources
    - Cans
    - Trucks
    - Storage Yards
    - Landfills
- Constraints
    - A truck can hold only one can
    - Truck/Can/Location compatibility
    - Can inventory at Storage Yards
    - Customer time preference (AM/PM/None)

Sam's Hauling



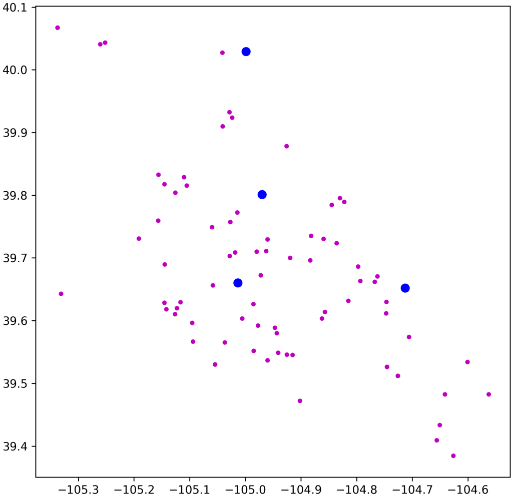
Blue: Storage Yard, Yellow: Landfill, Green: Delivery, Red: Pickup.

Sam's Hauling



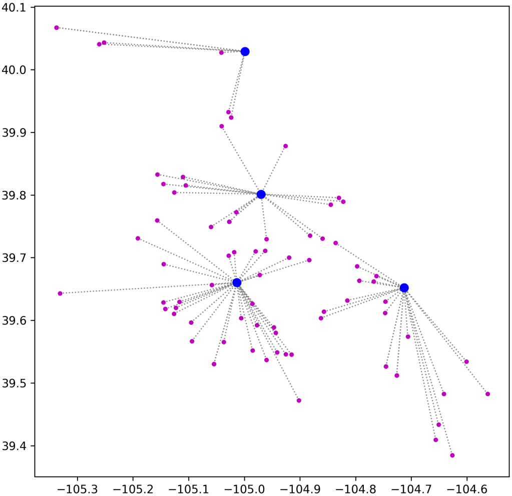
Blue: Storage Yard, Green: Delivery, Red: Pickup.

Simplify



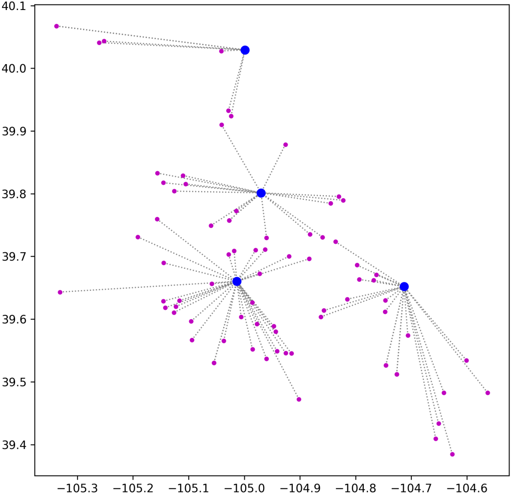
What if they were all switches?

Simplify



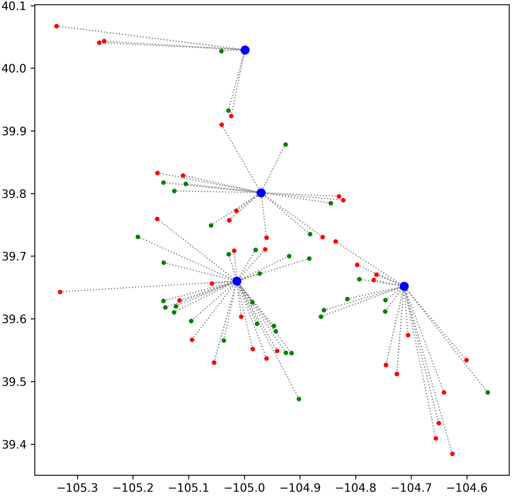
Associate each with the nearest storage yard.

Simplify



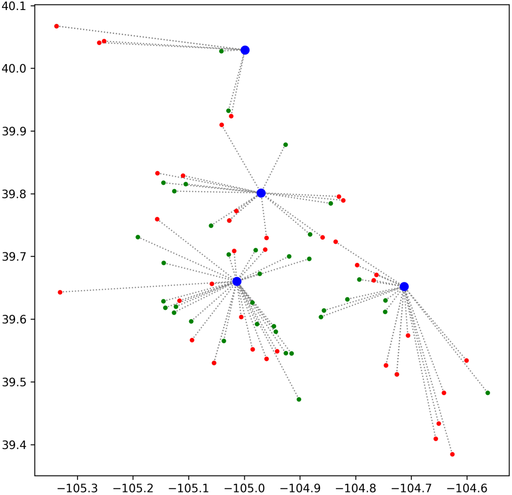
Transitions will come later. For now, we will teleport.

Back to Reality



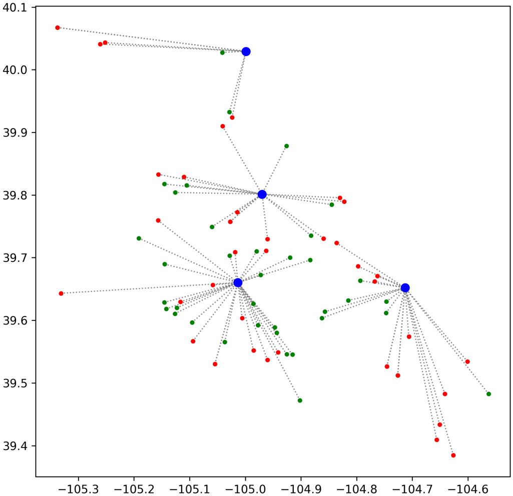
Deliveries and Pickups

Back to Reality



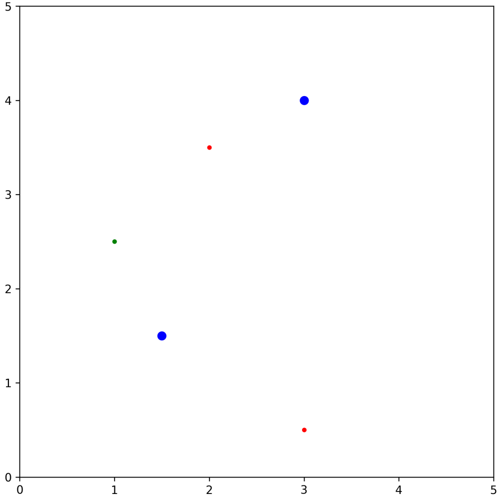
After a delivery, the driver has an empty truck.

Back to Reality



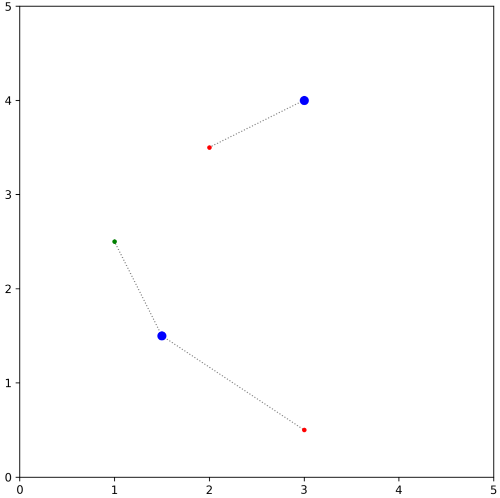
With an empty truck, we can go do a pickup...

A Small Example



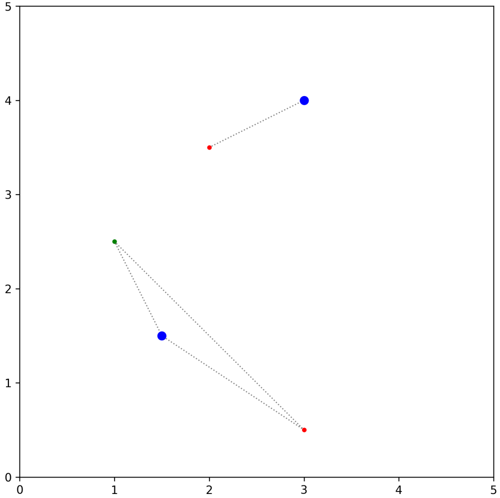
Nothing too complicated...

A Small Example



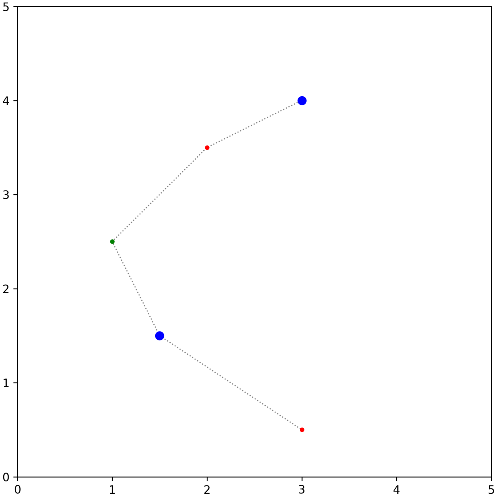
Stars

A Small Example



A triangle

A Small Example



A better "triangle"

A Question

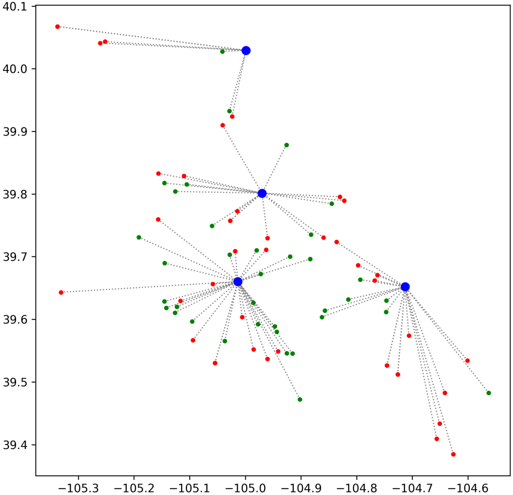
How do we find the best triangles?

It turns out this problem has been studied before, between two sets (here, deliveries and pickups), what is the least "cost" way to match them up?

Kőnig and Egerváry

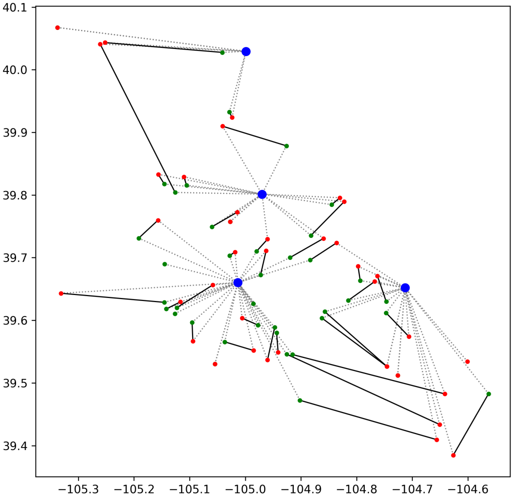
In this context, "cost" means driving time.

The Best Triangles



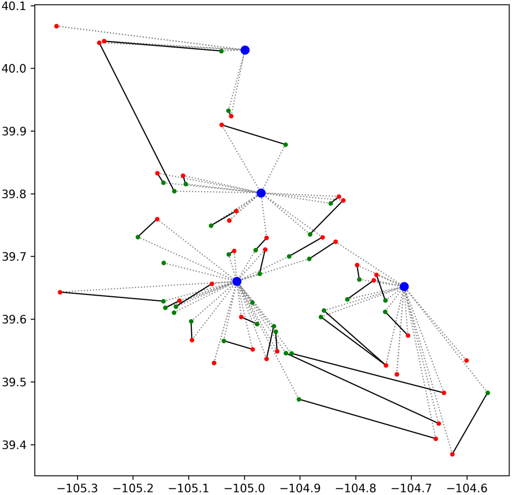
What do they look like here?

The Best Triangles



Tada!

Moving Between Stars



To go from one star to another, a choice must be made.

A Balancing Act

Sometimes, the zone surrounding a storage yard may need more deliveries than the yard has cans.

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In order to remedy this, we take into account can inventories while making transfers, and verify that we don't tell a driver to pick up a can from a yard which doesn't have any.

Where a Truck Must Go

Some trucks are special, they may be small enough to go where others can't, or big enough to carry heavy loads that others can't. The problem is, there aren't many of them.

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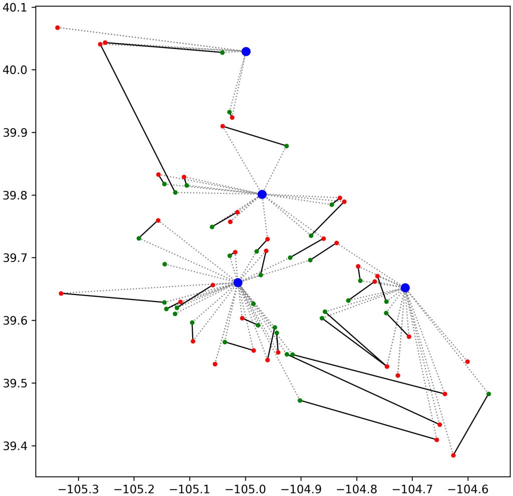
There are jobs that only these trucks can do. In order to be certain that these jobs get covered, we make sure that they are taken care of first.

Basically,

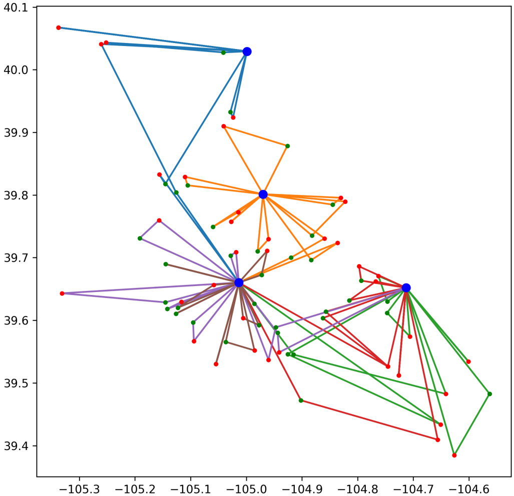
1. Receive data
2. Create optimal delivery/pickup pairs
3. For each driver:
    1. Choose a transition to a nonempty zone (if they need a can, bring one)
        - Special Truck: Go to a zone which has jobs requiring that truck.
    2. Complete compatible jobs (satisfying truck size and time constraints) until the zone is depleted (choose another transition), or until driver's schedule is full.
        - Special Truck: If dependent jobs in zone are depleted, transition to another zone that needs it.
    3. Choose a transition to return to home base
4. Output schedule

Teleportation



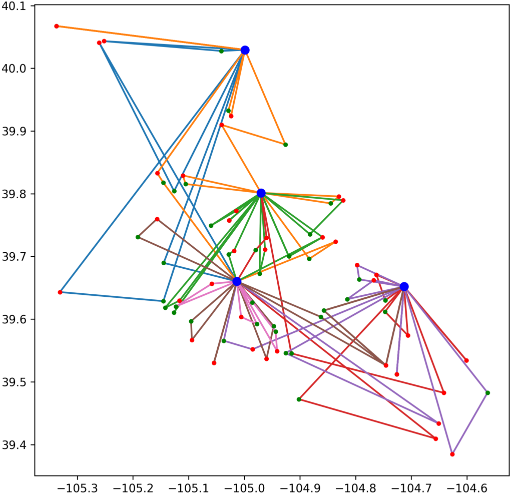
If drivers could teleport, 1534 minutes of driving.

Our Route, No Can Constraints



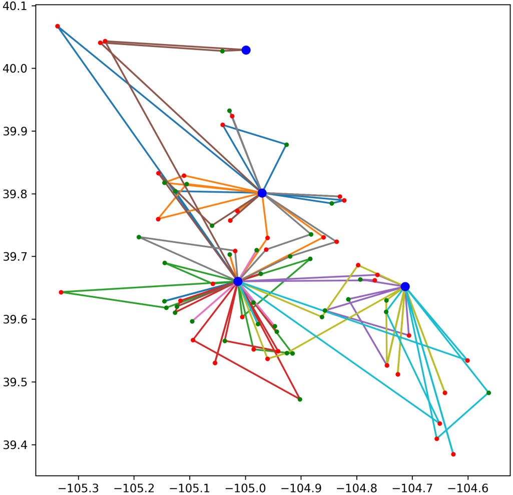
Our route, 1576 minutes of driving.

Our Route, Highly Restricted Cans



Our route, 1781 minutes of driving.

Sam’s Route



Sam’s Route, 1945 minutes of driving.

Comparison

Name	Minutes	% TP	% Sam's
Teleportation	1534	0.0	21.1
No Can Constraints	1576	2.7	18.9
Can Constraints	1781	16.1	8.4
Sam's	1945	26.8	0.0

Improvements

We are pleased with the outcome, the algorithm is quite fast and gives decent results. Though, there are some things which would make it better.

- Data (Driving Times)
- Data (Constraints)
- Better Pairs (?)
- Usability

What we covered

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Thank You.

References